

1 REPRESENTING, CONFIGURING, ADMINISTERING,
2 MONITORING, AND/OR MODELING CONNECTIONS USING
3 CATALOGS AND MATRIXES

4 CROSS REFERENCE

5 This invention application is cross referenced with
6 Docket Number YO999-272, entitled, "DISPLAYING,
7 ORGANIZING AND EMPLOYING EMBEDDED INFORMATION," by
8 Louis Herzberg et al., even-dated herewith, and is
9 incorporated herein by reference in entirety.

10 FIELD OF THE INVENTION

11 This invention relates to the field of network
12 connection. More particularly, the invention relates to
13 user interface and representation of connectivity.

14 BACKGROUND OF INVENTION

15 This invention addresses the problem of intuitively
16 representing and managing large data stores of
17 information relating to network configuration,
18 connectivity, resource utilization, connection
19 management and service availability. Although this
20 problem is particularly relevant in computer
21 controlled communications networks, it is also
22 prevalent in other types of networks which require

1 specified interconnectivity of a large multiplicity of
2 network elements. Network administrators lack intuitive
3 tools to retrieve and view status of network elements
4 organized in a number of different formats, such as by
5 user, by host, by connection type etc. The
6 administrators also need simple means of querying,
7 adding and deleting information from the store.

8 Broadly speaking, there are two general methods of
9 configuring, administering, monitoring modeling
10 networks: graphical and non-graphical. This invention
11 defines a method of using a non-graphical intuitive
12 method for organizing information using "catalogs" (or
13 lists), methods for creation and manipulation of
14 elements within catalogs, methods for presentation of
15 catalogs, manipulation of catalogs and linking of
16 tasks to catalog elements.

17 In networks with more than a few connections between
18 network elements, graphical methods that show
19 connections among network elements as visible lines
20 are hampered by the size of display area required to
21 show the connections in a useful way. This method is
22 also limited in the amount and type of information
23 about the connection and network elements that can be
24 shown. Practically, with more than a few 10s of
25 connections, the number of lines becomes so large that
26 a graphical display (either on screen or on paper)
27 becomes too cluttered to be useful. Figure 1 shows an
28 example of a network 100 having ten elements, 101-110,
29 which are mesh connected. No additional information
30 (such as type of link, link status, traffic load,

1 configuration options, etc.) beyond connectivity among
2 elements is shown in the figure. Even with only this
3 one piece of information, the graphical image is
4 beginning to become unusable. Thus a better method of
5 representing connections between network elements is
6 needed.

7 The following are definitions of terms as used herein:

8 Network Element - the start or end point of a
9 connection.

10 Sub-element - element that is a member of a
11 catalog that is itself an element in a catalog.

12 Catalog - a named set of elements. The catalog
13 elements can be atomic or can themselves be a
14 catalog, thus enabling catalogs of catalogs of
15 catalogs and so on.

16 Sub-catalog - A catalog included in another
17 catalog.

18 SUMMARY OF INVENTION:

19 It is therefore an aspect of the present invention to
20 present a method, apparatus and architecture for the
21 representation visualization, manipulation,
22 administration, monitoring and modeling of connections
23 between elements of a network.

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1 The invention includes catalogs of elements and the
2 manipulation of elements and/or catalogs, matrix
3 display and/or representation of catalogs and
4 manipulation of the matrix.

5 Aspects of this invention include:

6 the ability to represent, in a practical method, a
7 large plurality of connections;

8 the ability to configure the connections;

9 the ability to abstract different level or views of
10 the network;

11 the ability to show information about the
12 connections organized on the basis of different
13 parameters;

14 the ability to monitor, execute problem
15 determination tasks and tune the connections; and

16 the ability to use the same information
17 model/connection representation as input to modeling
18 tools.

19 Another aspect of this invention is the ability to use
20 a common view of the network for configuration,
21 monitoring, problem determination, tuning, modeling,
22 etc.

1 These and other objects are provided in a connection
2 representation scheme wherein a connection matrix is
3 employed. Other objects and a better understanding of
4 the invention may be realized by referring to the
5 Detailed Description.

6 BRIEF DESCRIPTION OF THE DRAWINGS

7 These and other objects, features, and advantages of
8 the present invention will become apparent upon further
9 consideration of the following detailed description of
10 the invention when read in conjunction with the drawing
11 figures, in which:

12 Fig. 1 shows a graphical representation of 10 network
13 elements mesh connected;

14 Fig. 2 illustrates an example of a High-level flow of
15 method;

16 Fig. 3 shows a matrix with Catalog "123" versus Catalog
17 "ABC" with one connection identified;

18 Fig. 4 shows a matrix with multiple connections at the
19 same intersection identified;

20 Fig. 5 shows an expansion of a Catalog Element;

21 Fig. 6 shows an expansion of a Catalog Element that is
22 in itself a Catalog;

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1 union of existing catalogs. Elements can be ordered,
2 added, moved and deleted from one or more catalogs.
3 Examples of object classes (the type of catalogs)
4 include one or more of the following:

- 5 • Endpoint catalog - which includes a set of
6 endpoint elements that can connect to other end
7 point elements.
- 8 • QoS catalog - which includes the types of (Quality
9 of Service) QoS that are available, e.g.
10 guaranteed latency, guaranteed bandwidth, best
11 effort, etc.
- 12 • Tunnel catalog - which includes the types of IPsec
13 tunnels that are available, e.g. weak tunnel,
14 normal secure tunnel, extremely secure tunnel,
15 etc.
- 16 • Encryption methods catalog - which includes the
17 types of encryption that are available, e.g. DES,
18 3DES, RC4, blowfish, etc.
- 19 • Validity catalog which includes the times that the
20 connection is valid, e.g., normal business hours,
21 not first shift, Saturdays 10 to 11 AM, etc.
- 22 • Action catalog - which includes the type of
23 actions that a user can do, e.g. halt traffic
24 between the endpoints, cause an IPsec key exchange
25 to occur immediately, update the monitoring
26 information, etc.
- 27 • Traffic Loading catalog - which includes the
28 network traffic characteristics (e.g. frame size
29 distribution, frame transmission distribution) for
30 use as loading input to a network model.

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1 Catalogs may be hierarchical such that the definition
2 of an element in a "higher" level catalog may be
3 created from and/or with elements of "lower" level
4 catalogs. For example, in creating the tunnel catalog,
5 one can select elements from a type of encryption
6 catalog, a validity time period catalog, etc. This
7 hierarchical construct allows multiple levels of
8 abstraction.

9 The catalogs are advantageously displayed using a
10 matrix method. An example embodiment creates a
11 catalog/element matrix with the elements of one or more
12 catalogs along row and column edges of the matrix. The
13 intersection of the elements in the matrix form a cell
14 (or block) which is useful to define actual or
15 potential connectivity. By manipulation of the elements
16 in the catalog, the network administrator determines
17 which sets of catalog elements are shown. This provides
18 a way of practically grouping and viewing connectivity.
19 It is also a method of abstraction because catalog
20 elements can themselves be catalogs. Figure 3 shows a
21 representative GUI, 300, showing the catalog matrix
22 with the "ABC" catalog, 310 and the "123" catalog, 320,
23 with the intersection, 330, of element 4 and element d
24 identified.

25 An embodiment creates directionality (simplex
26 connections) either within an intersection cell or by
27 the positional construct of one catalog's elements (say
28 the one displayed on the vertical axis) to the other
29 catalog's elements (say the one displayed on the

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1 For simplicity in illustrating the concepts of the
2 present invention, only one duplex connection is shown
3 between endpoints in the figures that follow. However,
4 those familiar with the art can easily implement the
5 concepts using other beneficial implementations for
6 single, duplex and/or multiple connections.

7 It is noted that the elements along a matrix axis can
8 be members of more than one catalog, and/or more than
9 one catalog can be displayed on each axis of the
10 matrix. Generally, both catalogs of elements, and
11 elements that are not in and of themselves catalogs may
12 be displayed simultaneously on an axis. Additionally,
13 it should be realized that the same catalog or set of
14 catalogs or elements can be display on both axes. When
15 this occurs and connectivity is assumed for all matrix
16 intersections, a mesh connected network results.

17 A star connected network results when a catalog having
18 multiple elements (or even other catalogs) is assigned
19 to one axis, a single element is assigned to the other
20 axis, and connectivity is assumed for all matrix
21 intersection cells.

22 The matrix display of catalogs is extended beyond the
23 concept of using the intersection of catalog elements,
24 to the concept of using each catalog element itself. In
25 the example that follows, the catalogs contain routers,
26 or network elements, that proxy or act as a gateway for
27 sets of network elements located "behind" the router.

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1 714, and potential tunnel users have been
2 previously populated. The question marks 720
3 indicate fields that when selected, a
4 "wizard" or catalog of possible values is
5 displayed. For example, a wizard is displayed
6 when the catalog of values is not complete or
7 to help in selecting the value from a
8 catalog.]

9 Step 2. For each field, select a value from a
10 catalog of possible values, 820.

11 Step 3. After selecting values for all fields, the
12 user has completed the configuration for the
13 connection between the two end points and the
14 configuration is stored for retrieval and/or
15 display as desired; 830.

16 It is noted that all examples are only representative
17 illustrations of the invention, and are not
18 comprehensive enumeration of the fields that must be
19 completed for configuration in a particular embodiment.

20 An embodiment for changing configuration is shown in
21 Figure 9. The same concept used for initial
22 configuration is used for modifying an existing
23 configuration. The steps are as follows:

24 Step 1. Given a connection exists between two end
25 points as shown by the intersection of an element
26 from two matrix displayed catalogs, the user

A further benefit of the representation of the present invention is the concept of matrix inheritance. As noted, making use of the abstraction property, one defines a matrix with a row of one or more catalogs versus a column of one or more catalogs. Generally, one or more of the catalogs includes elements that are in and of themselves sub-catalogs. The concept of inheritance provides the ability of propagating an inheritable action and/or attribute to an entire inheritance group. In one embodiment this is accomplished just by performing, adjusting or setting that action/attribute at a group parent. In alternate embodiments the action/attribute is inherited by performing, adjusting or setting that action/attribute at any group member. Thus, when an action (e.g. setting a parameter) is done at a intersection cell, then this action is inherited by all elements of all the sub-catalogs of catalogs in the entire inheritance group.

For instance, if the highest level catalog, named *east coast*, contains 4 elements which are in and of themselves sub-catalogs, (named: *Miami*, *Atlanta*, *Durham*, *Hawthorn*), and each of these contains 3 elements which are in and of themselves sub-catalogs, (e.g., the *Miami* catalog contains *router 1*, *router 2* *router 3*), and each of these contains 3 elements, (e.g. the *router 1* catalog contains elements *interface 1*, *subnet w.x.y.z*, *IP address a.b.c.d*) and a 1x1 matrix of *east coast* versus *east coast* was specified, any action done to the intersection formed by the 1x1 (single-cell) matrix (being the group parent) is

1 reflected into all the 1296 connections included within
2 that single matrix cell.

3 In accordance with the present invention, the matrix
4 display concept can be used in the context of
5 monitoring of all or some connections. Given that the
6 intersections in the matrix can indicate connections,
7 one can display many dynamic parameters of elements,
8 connections and/or catalogs with the use of colors or
9 symbols. As an illustration, one embodiment uses the
10 following color scheme, applied at the intersection
11 point of elements in the matrix catalogs, to display
12 status about connections between elements in the
13 catalogs:

14 Black - connection is not currently configured;
15 Yellow - connection is configured, but not
16 currently enabled;
17 Green - connection is configured, enabled and
18 operating correctly;
19 Red - connection is configured and enabled but not
20 operating correctly (e.g. QoS not being
21 maintained); and
22 Flashing Red with sound - connection has a serious
23 problem, e.g. a potential security violation such
24 as hacker attempting to insert traffic into the
25 connection has been detected.

26 The different types for "monitoring" information that
27 can be displayed is large and limited only by
28 imagination of the implimentor. Other examples include
29 performance or loading information, i.e. yellow - no

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1 traffic observed in last observation period, green -
2 medium loading, red - more than 85% utilization,
3 flashing red - excessive packet loss.

4 Figure 10 shows a black and white example of displaying
5 monitored connections using different types of cross
6 hatched lines for different status items. It shows the
7 status indicated by the direction of the slash.

8 1010 (No lines) - no connection configured;

9 1020 (Grid slashes) - connection configured, but
10 not enabled;

11 1030 (Reverse slashes) - connection configured,
12 enabled and operating correctly;

13 1040 (Horizontal slashes) - connection configured,
14 enabled but not operating correctly (e.g. QoS not
15 being maintained);

16 1050 (Vertical slashes) - hacker attempting to
17 insert traffic into the connection. A BEEP
18 indicates an audio alarm is sounded.

19 It is noted that Figure 10 is only an illustration. It
20 is not a comprehensive enumeration of the information
21 that can be displayed. Furthermore, the monitoring and
22 displaying functions are not limited to the
23 connection, but can be extended to the resources that
24 make up the connection or that constitute the end
25 elements, etc. As known to those skilled in the art,

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1 the concepts of this invention do not have a dependency
2 on the type of information displayed. For example, it
3 can be dynamic and/or static, fixed or variable, short
4 form or long form, continuous or intermittent, etc.

5 In accordance with the present invention, the
6 connection representation concept is useful among other
7 things, for identifying and solving network operation
8 problems, tuning parameters of network elements and/or
9 connections, and scheduling specific tasks that are
10 triggered by events in the network or simply initiating
11 them directly. This may include actions or tasks for a
12 connections. Thus, since intersections in the matrix
13 can indicate information about connections, one can be
14 provided with an ability to select ("click on") an
15 intersection and initiate an action or task.

16 Example of actions or tasks include:

- 17 • Retrieval of additional information/statistics
18 (such as bytes/sec, size of frames, traffic
19 rate ranked by sending address, etc.)
- 20 • Take action (such as test connectivity between
21 the endpoints, manually refresh the keys, halt
22 traffic, etc.)
- 23 • Tuning one or more connections (such as alter
24 the QoS parameters, change the mix of traffic
25 allowed through the connection, alter buffer
26 sized, etc.)
- 27 • Setting alarms, alerts and/or thresholds to use
28 when monitoring a connection.

1 An example illustrating a problem determination process
 2 is shown in Figure 11. Figure 11 uses the connection
 3 matrix, 300. One selects an intersection and brings up
 4 a display, 910, that aids in problem determination or
 5 tuning. This could include the setting of thresholds,
 6 etc.

7 An embodiment of the present invention performs
 8 modeling as shown in Figure 12. The figure shows steps
 9 for the matrix display being used as an input method
 10 for modeling tools.

11 Step 1. Using the matrix method described
 12 above, 1210, one defines the network to be
 13 modeled, 1220, i.e., define the resources
 14 (endpoints) and the connectivity between
 15 resources;

16 Step 2. Given a matrix of connections, 300, one
 17 could select an intersection, 1230, and define
 18 the attributes, 1240, of the connection, i.e.
 19 maximum frame size, TCP/IP window size, etc.
 20 One could also define the attributes of the
 21 endpoint, i.e. buffer size, speed, etc.;

22
 23 Step 3. Given the matrix of connections and
 24 endpoints and their capabilities, one could
 25 then:

- 26 • Define a work load to flow through the
- 27 connection and/or between endpoints;

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1 An example of an application is the
2 representation of database applications that
3 have connectivity between themselves;

4 An example of a MAC layer are MAC address
5 domains connected by LAN bridges. Other
6 examples are known to those skilled in the art.
7

- 8 • IP networks where elements are devices that
9 contain an IP protocol stack;
- 10 • Switching systems, including data or telephone
11 systems;
- 12 • Water systems where the elements are the supply
13 points and the usage points; and
- 14 • Distribution systems where the elements are
15 warehouses and retail stores.

16 The representation method and framework consists of
17 grouping the elements into catalogs or sets. A catalog
18 is created by standard combinatorial operations that
19 include but are not limited to the following:

- 20 • add an element to a catalog;
- 21 • delete an element from a catalog;
- 22 • change an element in a catalog;
- 23 • copy or move an element from another catalog;

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1 techniques or other methods known to those skilled in
2 the art. Alternatively, making use of the abstraction,
3 one could form a higher-level abstraction of the
4 elements by forming catalog element(s) that contains at
5 least a portion of the elements and displaying the
6 abstracted catalog elements.

7 If any of the element of a catalog are catalogs in and
8 of themselves, i.e., the element is called a catalog
9 element and it contains sub-elements, the intersection
10 within the matrix of a catalog element with either
11 another catalog element or an atomic element represents
12 both the catalog element and the atomic element
13 relationship abstraction and the sub-elements of that
14 catalog element with the other elements. This can be
15 represented by another matrix, called a sub-matrix,
16 whose axis contain the sub-elements of the catalog
17 element and if present in the original matrix
18 non-catalog elements. It should be recognized within
19 this new sub-matrix, there may be intersections of
20 elements that are catalog elements and this process of
21 creating a new sub-matrix can be repeated. A
22 sub-matrix can be formed when, in the matrix there
23 exists a intersecting cell formed by either a catalog
24 element paired with another catalog element or atomic
25 element.

26 The matrix representation may also be made to represent
27 directionality of the connections between elements.
28 For example, it could be defined that the flow of
29 traffic within a connection originates from the elements
30 on one axis and terminated in the elements of the other

1 axis. Further, if the same elements were placed on
 2 both axes, except for the matrix diagonal, each pair of
 3 elements (one member of the pair from one axis, the
 4 other member of the pair from the other axis) would be
 5 represented twice, i.e., {a,b} and {b,a}. If the
 6 matrix was constructed to represent directionality,
 7 each pair would explicitly show the flow in one
 8 direction, {a,b} from a to b and {b,a} from b to a.

9 If in the matrix, an element on an axis is in and of
 10 itself a catalog, then the connection relationship
 11 represented by a matrix intersection cell associated
 12 with that catalog element applies to all sub-elements
 13 represented by the catalog element.

14 Catalogs do not have to be unique, either in their
 15 structure or their members, i.e., two or more catalogs
 16 can have identical sets of elements. Furthermore, two
 17 catalogs may have only a portion of their elements that
 18 are identical. Also, when defining the matrix, the same
 19 catalog can be used for specifying elements on both the
 20 axes or two catalogs can be used, one for each axis. In
 21 the former case, obviously, elements on one axis are
 22 identical to those on the other. However, the same
 23 configuration will also result when two catalogs are
 24 used that have identical composition. In general,
 25 elements on the two axes of the matrix may have none,
 26 some or all of the elements that are common depending
 27 on how catalogs are chosen for the axis.

28 This method can be used to represent a wide variety of
 29 networks used in communication, including virtual

1 networks and overlay networks. Virtual networks are
2 often formed by logically partitioning a network's
3 physical connectivity to give the appearance of a
4 physical network that is a logical subset of the real
5 network. Overlay networks are sometimes synonymous
6 with virtual networks, in that a logical network is
7 "overlayed" onto a physical network or a portion of a
8 physical network. More generally, an overlay network is
9 an abstraction of a subset of the real network that is
10 defined by availability of specific service. Examples
11 of these types of networks include but are not limited
12 to:

- 13 • IPsec networks which provide secure "tunnels"
14 between points in the network,
- 15 • Quality of Service (QoS or QOS) networks which
16 attempt to provide a class or quality of
17 service for the traffic between points in the
18 network.
- 19 • Multiprotocol Label Switching (MPLS) networks
20 which use MPLS methods to set up paths through
21 the network.
- 22 • Virtual LAN (VLAN) networks which form logical
23 LAN(s) based on a subset of the connectivity
24 available in the real physical LANs.

25 This method can be used to configure all of the
26 possible connections between the catalogs or it can be
27 used to configure a portion of the connections.

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1 elements, their connectivity or some other relationship
2 that exists between the elements, one can also use the
3 same representation to aid in monitoring aspects of
4 this relationship. For example, if the intersection
5 represented a connection, one could display monitoring
6 information about the connection. This could be items
7 like the connection state (is the connection active?),
8 the throughput of the connection, accounting
9 information such as how long the connection has been
10 active or if the throughput is or has exceeded the
11 committed information rate for the connection. Because
12 the intersection can be created when one or both of the
13 elements are catalogs in and of themselves, the
14 information represented by the intersection can
15 represent an abstraction or summary of the information
16 for all or part of the elements that are contained in
17 the element that is in and of itself a catalog. For
18 example, if the two elements forming the intersection
19 were *East_Coast_Routers* and *West_Coast_Gateways*, and
20 these elements were catalogs in and of themselves, each
21 containing some number of routers and gateways, the
22 intersection of the elements *East_Coast_Routers* and
23 *West_Coast_Gateways* could result in the display of a
24 monitoring of the number of bytes transferred between
25 the two elements (*East_Coast_Routers* and
26 *West_Coast_Gateways*). This number of bytes would be
27 the sum of all bytes transferred between all routers
28 and gateways (all the sub-elements derived from the
29 elements *East_Coast_Routers* and *West_Coast_Gateways*)
30 that were represented or abstracted into the elements
31 *East_Coast_Routers* and *West_Coast_Gateways*.

1 If there is one element in a catalog and multiple
2 elements in another catalog, the resulting matrix can
3 be said to represent a star network because the
4 representation of the connectivity is between the one
5 element and the multiple elements, a one-to-many
6 topology. If there are multiple elements or there is an
7 element that is in and of itself a catalog of elements
8 in the catalogs that are positioned along the axis of
9 the matrix, the resulting matrix can be said to
10 represent a mesh network, because the representation of
11 the connectivity is between multiple elements on each
12 axis and there is a connection between each element on
13 one axis to every element on the other axis.

14 A wizard is a tool that aids a person doing a task.
15 Wizards are used to create catalog elements or
16 attributes associated with an element or group of
17 elements. Wizards are also used to aid the creation or
18 deletion of a connection or the modification of an
19 attribute of the connection. For example, a wizard may
20

- 21 • assist in organizing a catalog;
- 22 • setting the initial values of attributes;
- 23 • help by generating context sensitive templates
24 for the elements or their attributes;
- 25 • assist in defining the relationships between
26 elements;
- 27 • setting the initial configuration between
28 elements; setting the ongoing relationship or
29 configuration between elements; and

1 this change could be reflected in the representation of
2 the catalog element or the abstracted connection
3 representation. For example, if the highest level
4 catalog, named *east_coast*, contained 4 elements which
5 were in and of themselves catalogs, named: *Miami*,
6 *Atlanta*, *Durham*, *Hawthorn*, and each of these contained
7 3 elements which were in and of themselves catalogs,
8 e.g., the *Miami* catalog contained *router_1*, *router_2*
9 *router_3*, and each of these contained 3 elements, e.g.
10 the *router_1* catalog contained elements *interface_1*,
11 *subnet_w.x.y.z*, *IP_address_a.b.c.d* and a 1x1 matrix of
12 *east_coast* versus *east_coast* was specified in which
13 an attribute was the same for all derivable connections
14 representations and one of the connections
15 representation's attribute was changed (e.g,
16 *east_coast/router_1/interface_1* was set to no
17 connection), the catalog's representation (e.g.,
18 *east_coast*) could indicated that the attribute was not
19 homogeneously applied to all of the derivable
20 connections representations. In a converse manner, if
21 an element was a catalog element containing
22 sub-elements, all derivable sub-elements would inherent
23 the attributes of their "patent" element. If an
24 attribute was not to homogeneously applied (inherited
25 by all sub-elements) to all elements, the catalog
26 element representation could indicate that the
27 attribute was not homogeneously applied to (inherited
28 by) all derivable sub-elements. Note that a
29 sub-element can itself be a catalog and contain
30 sub-elements.

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1 These techniques can be extended beyond the
2 configuration and administration tasks to monitoring at
3 least some portion of the network. In addition to
4 attribute type information for elements or the
5 representation of the connection, one can display
6 monitoring information about the elements or the
7 representation of the connection. For example, one
8 could show, at the matrix intersection, the status of a
9 connection. Examples of status include: whether the
10 connection is active or not, the throughput of the
11 connection, the number of dropped packets/frames due to
12 a quality of service definition. One can also show
13 status associated with the elements at the edge of the
14 matrix. Examples of status include: number of frames
15 transmitted, number of attempts by an unauthorized
16 entity to access the element, average size of outbound
17 buffer used, number of configured tunnels, number of
18 active tunnels. Status can be dynamic or static. The
19 monitored information may be displayed in the form of
20 text, graphics or audio. Examples include a text that
21 is color coded per the status information; for example,
22 a correctly functioning connection may be displayed in
23 a color, such as green, while a failed connection may
24 be displayed in a color such as red. An intrusion
25 attempt may cause an audible alarm. A change in the
26 performance of a connection may be shown. Status for a
27 connection could show a bar graph of the utilization of
28 the connection by connection type. Many other examples
29 of monitoring the status and methods of displaying the
30 information are known to those skilled in the art.

1 This invention can be manufactured in a variety of
2 forms, including but are not limited to:

- 3 • web based methods in that web pages are used to
4 create this invention.
- 5 • Java based methods,
- 6 • stand alone programs,
- 7 • integrated into other existing programs.

8 The invention can be implemented and/or distributed in
9 a variety of forms, including:

- 10 • diskettes,
- 11 • disks,
- 12 • CDs,
- 13 • tape,
- 14 • downloads from a server (including web based
15 downloads).
- 16 • and/or other techniques known to those in the
17 art.

18 The invention may be implemented as a network apparatus
19 comprising: a matrix module forming a network matrix
20 having at least one matrix row element and at least one
21 matrix column element, and a plurality of network
22 catalogs. Each of the catalogs listing at least one
23 network element. The intersection of each matrix row
24 element with each matrix column element forms a matrix
25 cell, Each network element of a first subset of

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1 cases the attribute modifier further causes an
2 inheritable change to be inherited by a group of
3 inheritors; and/or a first network element is a first
4 proxy; a second element is a second proxy, and the
5 attribute is setting a Quality of Service, and the step
6 of causing causes the Quality of Service policy to be
7 set at all elements included in the first and second
8 proxies; and/or a first element is a catalog of
9 sub-elements, the attribute is setting an encryption
10 policy, and the step of causing causes the encryption
11 policy to be set at all sub-elements of the first
12 element.

13 The invention may further be implemented as a method
14 comprising: forming a network matrix having at least
15 one matrix row element and at least one matrix column
16 element; forming a matrix cell at each intersection of
17 each matrix row element with each matrix column
18 element; and forming a plurality of network catalogs;
19 listing at least one network element in each of the
20 catalogs; setting the network element of the catalogs
21 to be the matrix row elements; setting a network
22 element of at least one of the catalogs to be the
23 matrix column elements, and forming a representation of
24 a connection requirement of each respective matrix row
25 element with each respective matrix column element
26 which form each particular matrix cell by the
27 particular matrix cell.

28 In some embodiments of the method at least one matrix
29 row element is a sub-catalog listing at least one
30 sub-catalog network element; and/or the method further

